does not see motor movement a system alarm is generated.

If the restriction optical yoke fails to sense the restriction valve closing when expected, a system alarm is generated.

If the air-in-line sensor detects air over a certain number of pumping steps, an "Air-In-Line" alarm is generated. Also during pumping, the air-in-line sensor pair is tested by an auxiliary transmitter/ receiver pair, failure of which will generate an alarm. If during pumping the pressure in the delivery chamber reaches a preset limit (determined by the selected maximum pressure), pumping stops momentarily while the restriction valve is opened. If the pressure does not drop within a few seconds, an "Occlusion" alarm or warning is generated. In addition, if the pump repeatedly reaches the preset pressure, an "Occlusion" alarm or warning will be generated, even if the pressure is released each time.

If there is not enough fluid available to refill the delivery chamber, or there is a large amount of air collected in the delivery chamber, the start of the following cycle will not be successful, and a "Solution" alarm will be generated.

The pumping rate can be changed during the Run state by using the DATA Keys to change the rate in the Rate Display, and then pressing the ENTER Key. If the ENTER Key is not pressed within a few seconds, the audible alarm will beep and the Rate Display will revert to its previous setting. The new delivery rate does not actually change until the ENTER Key is pressed. Once the ENTER Key is pressed the pump will calculate the new delivery parameters and initiate the rate change immediately.

For safety and reliability during delivery, the management processor performs what is called a co-processor function. It tracks the operation of the pump processor and if it determines that the pump processor is not delivering fluid properly, it stops the system and generates an alarm. This prevents a single software bug, damage or temporary data loss from causing an incorrect delivery.

5.7.4 Keep Vein Open State Operation

When the Primary Volume to be Delivered display decreases to zero, the pump enters the KVO state. The ALARM INDICATOR is turned on while the RUN INDICATOR continues to operate. The audible alarm sounds periodically, and the Information Display displays the KVO message. The maximum pressure setting reverts to the preset value if it automatically was increased to compensate for 400 ml/hr or higher flow rates, and if the selected delivery rate is above 3.0 ml/hr, it is reduced to 3.0 ml/hr. The Volume Delivered value continues to be increased as fluid is delivered. This state will continue indefinitely, until either fluid runs out, giving a "Solution" alarm, or the HOLD Key is pressed to go into the Hold state. Once the instrument goes into the Hold state, the pump will not run again until the Volume To Be Delivered value has been set above zero (unless the automatic Piggyback Callback method is being used as described earlier).

5.7.5 Alarm State Operation

Whenever the microprocessor detects an alarm condition, the Alarm state begins immediately. If the pump is in the Run state when the alarm occurs, the main motor immediately retracts (as if it were the end of a pump cycle) and then stops. The ALARM Indicator is illuminated and the audible alarm chimes. At the same time, the Volume To Be Delivered and Rate displays will flash an abbreviated

alarm message, and the Information Display will display a message which indicates the cause of the alarm. The user will be given the option to display a screen suggesting steps to take to eliminate the problem. This alarm mode can continue since the NiCad backup battery on the main board will operate the backup alarm if the pump's main battery fails.

When the HOLD Key is pressed, the audible alarm is silenced and the system reverts to the Hold state. Once the cause of the alarm has been corrected, the infusion can be restarted by pressing the RUN Key. In the case of a few serious system alarms, which are indicated by the "Repair Instrument" alarm message, the instrument must be turned off and back on before RUN can be pressed.

In some cases where one or more of the processors fail or the battery is deeply discharged, the system might generate either a chiming or high-pitched tone which is the backup alarm, and the HOLD Key does not shut it off. In this case, pressing the POWER Key and possibly removing the AC power to shut off the pump will silence the alarm.

If the main PCB is removed while the backup alarm is still activated it can be deactivated by touching the two contacts on the front of the PCB as shown in Figure 5-1, Item 13.

6.0 CLEANING AND DISINFECTING

6.1 RECOMMENDATIONS

Clean the pump with a soft, lint-free cloth dampened (not saturated) or swab using any of the following recommended solutions:

Household Bleach and 90% Water

Isopropyl Alcohol

Warm Soapy Water

DO NOT allow fluids to enter the pump during cleaning and disinfecting.

Once the infusion pump is cleaned, **wipe the entire pump twice with fresh water** using a soft, lint-free cloth to remove all remaining cleaner/disinfectant. Then thoroughly dry the instrument with a soft, lint-free cloth.

To avoid mechanical damage, DO NOT use acetone, solutions containing glutaraldehyde, ammonium chlorides or abrasive cleaners on the instrument.

Please refer to the hospital's housekeeping, central service, or infection control department for further information.

WARNING: To avoid electrical shock, turn the pump off and disconnect it from the electrical outlet before cleaning.

WARNING: To avoid electrical shock, insure that the AC power connector is clean and dried thoroughly prior to connecting the power cord.

CAUTION: To avoid mechanical or electronic damage, DO NOT steam autoclave or immerse the pump in any fluids or cleaning solutions.

CAUTION: Sterilization of the pump using ethylene oxide (EtO) gas or Autoclaving is not recommended.

CAUTION: Do not clean the pump using high pressure devices.

7.0 PREVENTIVE MAINTENANCE AND REPAIR

7.1 PREVENTIVE MAINTENANCE PROCEDURES

Because preventive maintenance is preferable to waiting until an instrument fails to function, it is recommended that the procedures for preventive maintenance as described in the section titled "Procedures Not Requiring Case Disassembly" be performed every 6 months, while those procedures listed in the section titled "Procedures Requiring Case Disassembly" be performed once each year.

WARNING: Do not perform these procedures and/or tests while the Horizon Nxt is in patient vicinity or while in patient use. Failure to comply could result in bodily harm.

WARNING: If the product is partially or completely disassembled, or a component or assembly has been replaced or repaired, the unit must undergo and pass all performance checks outlined in Section 3.6 of this manual and the appropriate calibrations and or tests outlined in Sections 3.7 and 3.8 prior to use for patient care. All final performance testing and calibration of the Horizon Nxt must be performed with a set that is acceptable for patient use with an exception for set sterility only. Failure to do so may cause bodily harm and will void all warranties and liabilities.

WARNING: Shock Hazard. Prior to disassembling or performing service on the Horizon Nxt Pump, it is recommended that the pump be disconnected from the AC power source unless you feel it is specifically required for a particular test. If you find it necessary to have the device connected to an AC power source, use a line isolation transformer and caution. Failure to do so could result in bodily harm.

WARNING: Shock Hazard. The inside of the Horizon Nxt case has a conductive coating which is connected to ground through the power supply module. When servicing the Horizon Nxt, use caution to prevent accidental shorting to this coating. Failure to do so may result in component damage or even bodily harm if a line isolation transformer is not used when the AC power supply cord has not been disconnected.

7.2 EQUIPMENT REQUIRED

7.2.1 Hand Tools

Table 7-1 describes the hand tools necessary to disassemble and reassemble various parts of the Horizon Nxt Pump for checkout and repair.

Table 7-1: Hand Tools

Tool Description	Size	Application
1. Phillips Head Screwdriver	#1 and #2	General
2. Small Blade Screwdriver	1/8" and 1/4" wide	General
3. Socket Driver	3/8"	Power Supply and Main Battery Removal
4. Needle Nose Pliers		General
5. Feeler Gauge	0.008 inch, 0.016 inch	Inlet Solenoid Adjustment
6. Standard Pliers		General
7. GO - NO/GO gauge	P/N: 402069 (available in Kit #FZ0029)	Outlet Valve Yoke Adjustment

7.2.2 Test Equipment and Materials

Table 7-2 is a suggested list of test equipment and materials for checkout, calibration and troubleshooting the Horizon Nxt Pump.

Table 7-2: Test Equipment and Materials

Equipment Description	Size	Suggested Brand (or Equivalent)
1. Digital Voltmeter	n/a	Fluke
2. Burette & Support	10 ml, 50 ml	KIMAX
3. Syringe and Needle	1cc and 10cc, 20 gauge, 1 inch or less	Becton Dickinson & Co.
4. Pressure Gauge (optional)	0 - 20 psig	Dynatech Nevada 207 Digital Pressure Meter
5. Digital Scale (1 mg accuracy)	100 g capacity	Mettler PC440
6. Medical Device Electronic Safety Analyzer	n/a	Dynatech Nevada 231D Safety/ ECG analyzer

7.2.3 Consumables

Table 7-3 lists consumable materials necessary for cleaning and reassembly of the Horizon Nxt Pump.

Table 7-3: List of Consumables

Material Description	Suggested Brand (or Equivalent)
1. RTV 3140, P/N 145005	Dow Corning 3140 RTV
2. 70% Isopropyl Alcohol	n/a
3. High bond adhesive	Henkel Adhesives Corp. Sicoment 8300
4. Syringe and Needle	Becton Dickinson
5. IV solution container	B. Braun
6. Horizon IV set	B. Braun
7. Silicone Spray	CRC Heavy Duty Silicone (available at many hardware stores)
8. Clear Lithium Grease	Permatex Industrial Super Lube. Multipurpose Synthetic Lubricant with Teflon
9. Cotton swabs	Johnson & Johnson

7.2.4 Spare Parts

A spare parts kit, standardized or custom designed, is available to provide parts and assemblies routinely required to service the Horizon Nxt pump. Other non-generic Horizon Nxt parts may be ordered on an individual basis when required. These parts are listed in the Parts List in chapter 8. Common, generic parts (screws, nuts, wire, etc.) are more readily available from suppliers in your area. Therefore, these parts are not available for sale through B. Braun.

7.3 PROCEDURES NOT REQUIRING CASE DISASSEMBLY (6 MONTH)

7.3.1 Mechanical Inspection

7.3.1.1 Door Alignment Inspection

1. Make sure the door of the pump opens and closes easily, without binding, and that it is uniformly aligned with the bezel. The door latch allows the door to close completely.
2. The gap on each side and along the top of the door is symmetrical.

7.3.1.2 Switch Inspection

1. Push the POWER Key to turn the pump on.
2. Verify the functionality of all keys.
3. Make sure there are no visible punctures or distortions on the pump membrane panel.

4. Push the POWER Key again to turn the pump off.
5. Verify the key panel is securely adhered to the cosmetic bezel.

7.3.1.3 Pole Clamp Inspection

1. With the Pole Clamp in the unlocked position, it will slide easily up and down with a spring action and return to the narrow pole position. Lubricate with CRC Silicone spray as necessary.
2. Rotate the Pole Clamp lever counterclockwise to make sure the locking mechanism is intact.
3. Return any defective Pole Clamp assembly for free replacement.

7.3.1.4 Gasket and Hardware Inspection

1. All gaskets and seals are securely attached.
2. Valve tips are in place and in good condition.
3. The cover on the pressure transducer shall not have any rips, tears, punctures, or indentation marks.
4. All screws are tight and secure.
5. No cracks in the bezel or inner door face are present.
6. Air-in-line tube pusher is intact and securely mounted.
7. No cracks in the case or handle exist.
8. Inspect the power cord for nicks or cuts. Inspect the plug for bent or insecure prongs.
9. Petal covers should be routinely replaced at the 6 month PM.

7.3.2 Main Battery Capacity (optional)

CAUTION: Continuous deep discharge of the battery may cause damage to battery cells and lead to premature battery replacement.

1. To check battery capacity, charge the batteries by connecting the pump to AC power. Allow the batteries to charge continuously for at least 24 hours. The pump can be infusing during this time since the rate of charge is independent of the infusion process.
2. Once fully charged, set the pump to infuse at 125 ml/hr, a volume to be delivered of 375 ml, and a 300 mmHg occlusion pressure limit setting.
3. Begin the infusion.
4. In approximately 4 hours, verify that the "PLUG AC" warning flashes on the unused channel rate LEDs and a tone with increasing frequency, but no more frequent than approximately once every 5 seconds, activates prior to the infusion stopping.
5. Allow the pump to infuse until it stops infusing completely.

Note: Total battery operational run time is dependent on factors such as age, routine charging maintenance, and rate of infusion. As with other medical equipment, it is recommended that the main battery be replaced on a 24 month basis.

Note: We have found that sealed lead-acid batteries can occasionally be "rejuvenated" by a full discharge/charge cycle. For example, if your test results in a two hour infusion, then recharge the battery and test again. On occasion, the results can double. This assumes that

the battery is undamaged.

Note: When the pump is first powered up after having infused until the emergency backup alarm activates, a "SYS Err" message will be generated. This is normal and desirable since the pump recognized that a power down occurred without the POWER Key being pressed. Simply cycle the pump off then on again to clear the alarm. This event will be stored in the internal logs as alarm code number 123.

6. Prior to patient use, allow the pump to charge at least until the "Check Battery Level" feature in the USER MENU indicates "FULLY CHARGED." To access this feature: Connect the pump to AC power, power the pump on, press the MENU Key, press the CURSOR Key until the feature is highlighted, press the ENTER Key. At this point, the battery status will be displayed. This screen can be left up for as long as desired simply by opening the door, thereby disabling the Hold alarm. This will allow you to see when the battery status changes to "FULLY CHARGED." A "FULLY CHARGED" message indicates the battery is at least 95% charged.

7.3.3 Simulated Use and Performance Check

Test Procedure: Simulated Use and Performance Check

Please follow the steps outlined in Section 3.6.

7.3.4 Volume Delivery Accuracy

Equipment Required:

1. Distilled water in an I.V. fluid container
2. Horizon® Pump I.V. Set
3. Electronic Balance **or** Precision Collection Vessel
4. Needle or dispenser tip with a Luer Lock type connector

Test Procedure: Volumetric

1. Connect the fluid delivery set to the fluid container.
2. Attach the needle to the delivery end of the I.V. Set.
3. Completely prime the set with fluid so all the air is expelled from the set, and then close the roller clamp on the set.
4. Insert the I.V. set into the pump according to the instructions inside the door of the Horizon Nxt pump.
5. Close the door and press the POWER Key to turn on the pump.
6. Open all clamps and enter:

Table 7-4: Volumetric Test Values

Volume	Rate	Pressure	Acceptable Limit
10 ml	120 ml/hr	300 mmHg	9.5 - 10.5 ml or grams

7. Place the collection vessel on the balance (if used), zero the reading, and suspend the needle over the collection vessel.
8. Press the Run Key.
9. When the pump goes into the Keep Vein Open mode, press the HOLD Key immediately. Make sure the actual volume delivered is between the limits listed in Table 7-4.

Note: 1 ml = 1 cc = 1 g distilled water at room temperature (70° F)

10. Zero the reading on the balance. If the actual values are not within the Acceptable Limit listed above, test the pump with additional I.V. fluid delivery sets. If the values remain outside the specifications, return the pump to an authorized B. Braun Service Center.

Note: If using other accuracy test methods, in addition to the above, be sure to compensate for the adaptive energy processing used to conserve battery power and reduce noise as described in section 5.5.7.2 "Motor Controllers." This dynamic processing of resistance to flow will cause the motor energy to rise and fall at the beginning of an infusion (each time the pump transitions from the hold State to the run State). This results in several (varies with the system dynamics and rate) momentary pauses of the motor as the energy is changed during the first few delivery cycles after the RUN Key is pressed. Manufacturers of biomedical test equipment will supply you with written instructions for use of their equipment when testing I.V. pumps which employ this type of energy processing. While volumetric analyzers are different, typically all that is required is that you allow 5-10 milliliters of fluid to bleed from the system prior to starting the timer(s) or counter(s). A 3 way stopcock is very useful here. Contact the manufacturer of your volumetric analyzer to ensure proper software and testing procedures are used.

7.3.5 Electrical Safety Check

Equipment Required:

1. Medical equipment type electrical safety analyzer
2. AC power source

Test Procedure: Electrical

1. Plug the analyzer into an AC outlet.
2. Make sure the analyzer is functioning properly, according to your institution's protocol.
3. Plug the pump into the AC outlet of the analyzer.
4. Attach the probe to a single lead and touch it to the aluminum plate which supports the Daisy Chain

outlet on the side of the pump or any protruding metal component.

Note: If using a manual probe for your resistance checks you will need to make contact with either the metal frame of the power supply, located next to the Daisy Chain outlet, or the stainless steel door latch. Being stainless steel, the door latch makes for a difficult contact; you may need to scratch and scrape the probe on the latch.

5. Set the grounding selection to "No Ground."
6. Set the polarity to "Normal."
7. Press the POWER Key to turn on the pump.
8. Press the Chassis Leakage button and make sure the reading does not exceed the UL 544 or the IEC 601-1 specifications as indicated below.

Note: The measurement will be highest during the refill cycle of an infusion and will last only momentarily.

Note: As of the date this manual was written, the AC leakage current specifications for both UL 544 and IEC 601-1 is 100 microamps for patient vicinity equipment. When using the Daisy Chain feature on the Horizon Nxt (plugging one Horizon® or Horizon Nxt into another), the chassis leakage current is cumulative. Therefore, test all units connected as one system. The number of pumps interconnected at any time should not exceed the 100 microamp limit. This specification should also be considered when using extension cords with any medical electronic device. The extension cord will increase the leakage current for that device and may thereby compromise the electrical safety of that device.

9. Set the polarity to "Reverse."
10. Press the Chassis Leakage button again. Make sure the reading does not exceed the UL 544 or the IEC 601-1 specifications.
11. Press the HOLD Key.
12. Set the polarity to "Off."
13. Set the grounding selection switch to "Ground."
14. Press the Ground Wire Resistance button. Make sure the reading does not exceed the UL 544 or the IEC 601-1 specification.

Note: As of the date this manual was written, the ground wire resistance specification for a device with a non-detachable power cord for UL 544 and IEC 601-1 is 200 milliohms.

15. Press the POWER Key on the pump.
16. Repeat steps 8 - 14, skipping step 16, with the power off.
17. Disconnect the pump from the analyzer. Disconnect the analyzer from the AC power source.

7.4 PROCEDURES REQUIRING CASE DISASSEMBLY (12 MONTH)

If you have not been performing a battery capacity test during your 6 month PMs, it is recommended (but optional) that you include this test in your annual PMs. B. Braun recommends replacing any batteries older than one year. Due to the length of time required to perform the test, you may wish to test only those devices which are used in an environment that charges the batteries in an erratic and infrequent manner, allowing them to fully charge very rarely, examples of which would be the Operating Room, Emergency Room and Recovery Room. Also included should be those devices which are suspect of having limited battery life. Refer to the section titled "Main Battery Capacity" for testing instructions.

1. Remove the case top as described in Section 7.6.1.
2. Check all components on the main PCB to ensure they are securely in place and undamaged.
3. Remove the battery from its case and inspect for damage.
4. Recheck all connectors on the main PCB to ensure they are securely in place.
5. Visually inspect all hardware mechanisms on the Horizon Nxt to ensure that they are secure.
6. Reassemble the pump and perform those procedures as outlined in Section 3.6 of this manual and the appropriate calibrations and or tests outlined in Sections 3.7 and 3.8 prior to use for patient care.

7.5 REPAIR

It is the intent of B. Braun to allow the Biomedical Service Professional to repair and/or replace most of the subassemblies, which represents our present procedure with other infusion devices that we manufacture. We do, however, require the Biomedical Service Professional to be certified by attending a B. Braun Repair Training class. If you wish to repair the device yourself and have any questions regarding training classes, please contact an authorized B. Braun repair facility (see Chapter 9).

7.5.1 Biomed Menu Option

Entering the Biomed Menu on the pump:

1. Press the POWER Key.
2. Press the MENU Key.
3. Press the CURSOR Keys to select "Alternate Menu."
4. Press the ENTER Key.
5. Press the CURSOR Keys to select "Biomed Options."
6. Press the ENTER Key.
7. A screen displaying the 4-digit security code is displayed
8. The security code is dependent on pressing the correct whole number Volume to be Delivered Keys in the proper sequence. Do not use the tenths key. Each key is pressed only one time. The number is created randomly each time the screen is shown.

Note: The user is allowed three successive chances to enter the appropriate security code.

For example, the correct key press sequence for "3421" is:

Ones - 1st
Tens - 2nd
Thousands -3rd
Hundreds - 4th

7.5.1.1 Alarm and Operation Logs

The Alarm and Operation Logs are the most useful tools available for troubleshooting the Horizon Nxt Pump. The unique feature of the logs is that each time an event is stored in the log, it is time and date stamped. The Operation and Alarm Logs will each hold 255 entries (32 bytes each) which can be down-loaded to a PC as frequently as needed. The file size on the PC will be approximately 55 kilobytes once down-loaded. It is estimated that under normal use, the Operation Log will store approximately one month's worth of information and the Alarm Log will store approximately 3-4 months of information. The length of time it takes to fill the log depends upon how frequently the controls of the pump are manipulated.

Once the log is filled, the oldest event will be discarded and the new event will be appended to the end of the list, in a First In First Out (FIFO) fashion. A tremendous amount of information exists in the logs, the uses of which are limitless. Several examples will be described below, but many more exist. Once familiar with the logs, they will become an invaluable diagnostic and troubleshooting tool. It is recommended that you familiarize yourself with the pump's operations by reading the included operation manual. While reading, have a pump nearby for experimentation. Once you have familiarized yourself with the pump, download the Operation Log and note how easy it is to repaint a picture of past usage.

The Alarm Log is similar to the Operation Log in many ways. The primary difference being that it stores the last 255 alarms instead of operations and therefore will hold approximately 3-4 months of alarm history. The Alarm Log is useful for giving a quick look at the alarm history versus having to wade through all of the user operations. The Operation Log holds all events, both alarm and user operations. It offers you the ability to view the use history of the device, thereby verifying that rates and volumes had indeed been entered as intended as well as determining those sequence of events that proceeded some particular alarm. When identifying the time of an event occurrence, first verify the time of day clock has been properly set by checking the "Review Time and Date" option in the Biomed Menu. If it has not; simply adjust it accordingly and add or subtract that amount of time from the log to determine the actual time of the event.

Note: When receiving a new pump or one which has been serviced, the logs will still have entries in them. There is no method to clear the logs of information. Since the device is tested for functionality prior to leaving the service facility or factory, these alarm entries will remain in the log.

If you download the logs on a regular basis and wish to save this information for future reference, a tremendous amount of disk space can be saved if you use a file compression utility on the files. Without compression you will only be able to store approximately 200 operation logs per 10 Megabytes of disk space. File compression, can reduce the amount of disk space required by approximately 85%, from 10 Megabytes down to 1.5 Megabytes. Many varieties of compression utilities are available from your local software dealer or through shareware. Please keep in mind that a certain amount of risk is involved when you alter the files and B. Braun shall not be responsible or liable for the loss or corruption of data.

To receive the file onto your PC, you will need to obtain a communications link that attaches to the back of the Horizon Nxt which serves to translate the IR signals into standard RS-232 voltages. This link will come with a 9 pin male cable, and can be connected to any standard comm port. If you do not have a free 9 pin port, simply attach a 9 to 25 pin convertor. This will allow you to connect the

link to 25 pin ports also. Most any PC communications package can be used to receive the pump's log information. The information can also be sent directly to a printer; in this case you will need refer to the printer's manual for serial port configuration DIP switch settings. Since the information is sent at such a high BAUD rate, the speed of the printer will need to be fast and it will need to have a sizeable buffer, such as 32 Kilobytes. The entire log will be transmitted in approximately 90 seconds.

Communication settings: 9600 Baud, no parity, 8 data bits, 1 stop bit

See APPENDIX C: Operation Log for examples of Operation and Alarm Logs.

7.5.1.2 Check Configuration and Software A/D Offset

This feature allows you to check the current software revisions in the device. It is recommended that you have this information available when communicating a problem to customer service representative. A definition of the display is as follows: MP = Management Processor, PP = Pump Processor, DP = Door Processor. Each is followed by the present revision level. Each processor may have a different revision level.

To test the software A/D pressure transducer offset value, you will need to install a fully primed cassette in the pump and begin an infusion. Then press the MENU Key until at the bottom of the USER MENU. Cursor up to select "Biomed Options" and press the ENTER Key. Press the MENU Key then cursor down to select "Check Configuration," and press the ENTER Key. With the software configuration information displayed press the down arrow CURSOR Key. The value displayed should be between 0 and 50 with a typical reading of 10-12. If the value is outside of these parameters refer to Section 7.7.1.1 for additional testing instructions.

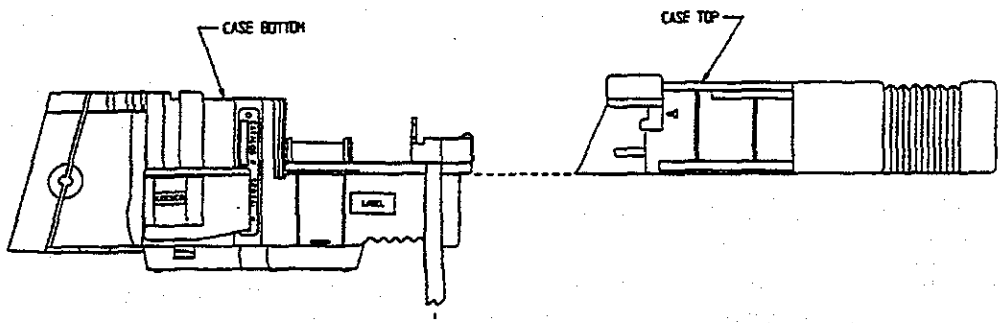
7.6 DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

The pump should be tested as defined in Section 7.4 "Procedures Requiring Case Disassembly (12 month)," following calibration or adjustment of any of the following items.

Note: It is good practice to wear eye protection while servicing the pump, especially during assembly and disassembly operations.

7.6.1 Case Halves

Figure 7-1: Case Half Separation



Removal:

1. Turn the pump off and disconnect from AC power source.
2. Locate the two quarter-turn screws on the back of the device. Turn each screw one quarter turn counterclockwise.
3. Unlock the Pole Clamp lever and pull it down to the bottom most position. Lock it in the open position by simultaneously applying a light pressure against the inside portion of the outer clamp jaw and turning the clamp lever in the counterclockwise direction. The final position of the clamp should be as in Figure 7-1.
4. Locate and remove the small Phillips flat head screw on the case top near the top of the Pole Clamp mechanism. See the Figure 7-1 or Figure 2-3.
5. Check to insure the Daisy Chain AC outlet door is closed and that the AC electrical cord is pulled in the downward direction.
6. Gently, yet firmly, slide the case top toward the rear of the pump.

Installation:

1. Refer to Figure 7-1 for a side view of how to position the case halves and AC power cord prior to assembly.
2. Look at the rear of the case bottom and note the small grooves, one on each side. These grooves are the channels that the case top will slide in. Place the case bottom on your work surface with the front facing yourself. Allow plenty of clear space above and behind the pump.
3. The AC power cord should be draped down beneath the pump.
4. The Daisy Chain door should be closed.
5. The Pole Clamp should be locked in the bottom-most position.
6. The Main PCB should be mounted flush against the case bottom mounts and all connectors secure.
7. Position the case top as in Figure 7-1. Carefully engage the left groove and begin to slide the case top forward towards yourself while holding it level with the case bottom. The right groove will engage next at which point the top may hang. Make sure the AC power cord remains draped out of the way and that the right groove has properly engaged. DO NOT force the top into place! If excessive force is used, damage may occur (usually the fuses go first).
8. The next point of resistance will probably be caused by the Main PCB. Reach your thumb up underneath the rear of the case top and hold down the rear edge of the Main PCB. Slide the case top forward until past this point. Release your thumb from the Main PCB.
9. Continue to slide the case top forward until the front edge of the case top meets the gasket on the top of the bezel. While pulling the left side of the case top forward press downward and forward on the top right side of the case top. This will ensure that the right side of the case top locks into the mounting hooks on the pole clamp.
10. Tighten the two turn screws on the back of the pump and the Phillips flat head screw as indicated in Figure 2-3. If the latter Phillips flat head screw does not thread, the mounting plate may need to be resecured. To do this, slide the case top back 2 to 3 inches and locate the metal triangular shaped mounting plate on the right side near the Pole Clamp. Check that it is aligned such that the screw will thread. If not, reattach with epoxy and reinstall the case top.

7.6.2 Pole Clamp

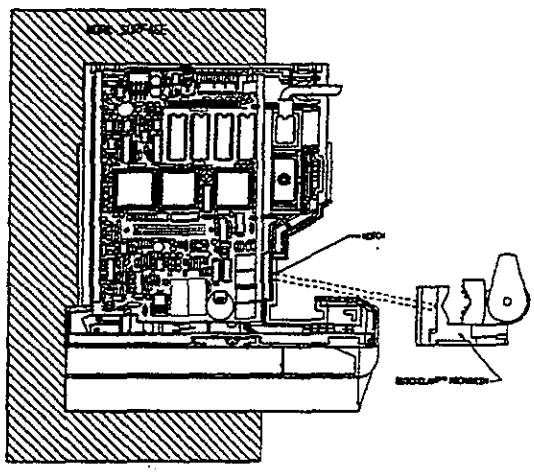
Removal:

1. Remove the case top.
2. Position the pump on your work surface as pictured. Be sure there is plenty of free space for the Pole Clamp to drop from the case bottom.
3. Locate the notched tab on the top of the Pole Clamp, see Figure 7-2. With a small flat blade screwdriver, gently clear the tab from the notch and push the Pole Clamp assembly downwards and away.

Note: It may be necessary to tap the Pole Clamp free.

4. Be sure not to lose the spring and guide wheel on the Pole Clamp mechanism as you separate it from the case bottom.

Figure 7-2: Pole Clamp Placement

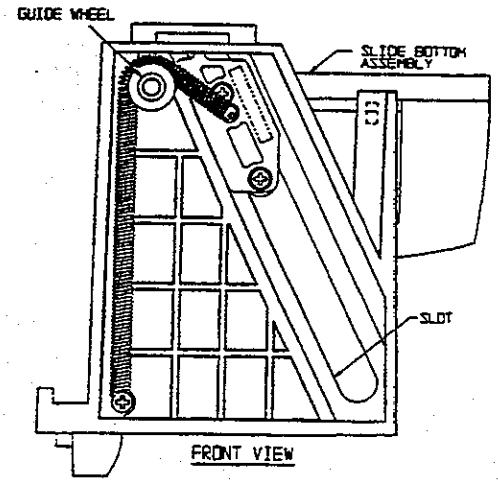


CAUTION: Actuating the Pole Clamp while detached from the pump can cause the spring's guide wheel to fly off.

Installation:

1. Be sure the spring is positioned around the guide wheel as pictured. This can be done by first attaching the spring to the screw, lower left screw in Figure 7-3, then slip the spring over the pin attached to the slide assembly.
2. Place the guide wheel against the spring and pull the wheel over the shaft.
3. Insert the Pole Clamp assembly into the case bottom by positioning the bracket such that it slides up through the bottom of the pump and locks in place.
4. Inspect the retaining tab on the top of the clamp mechanism making sure it is securely fitted and locked into the notch.

Figure 7-3: Spring Placement



7.6.3 Management and Pump Processor EPROMs and Fuses

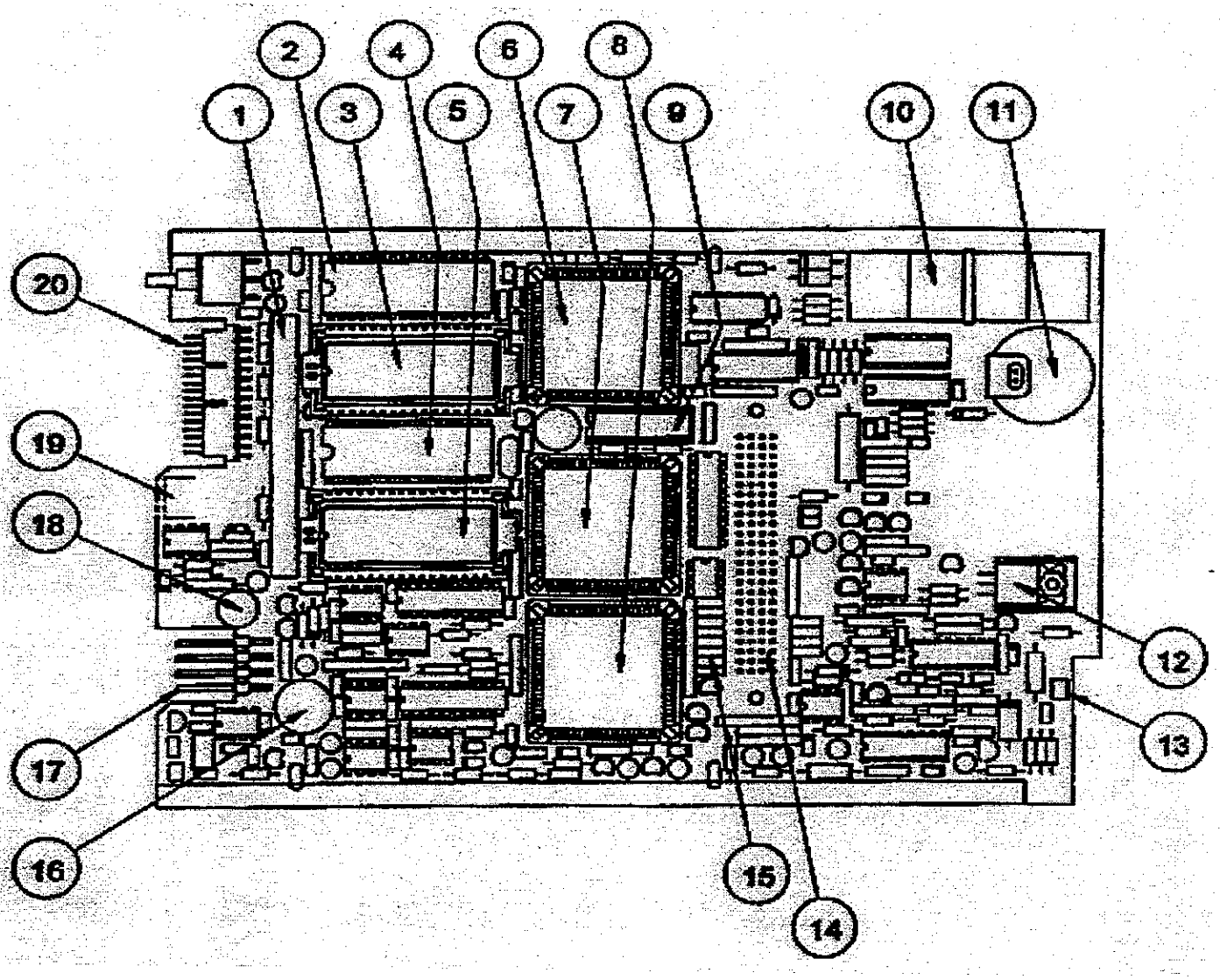


Figure 7-4: Main PCB and EPROM Removal

1. Option Board Connector
2. Pump Processor memory
3. Pump Processor EPROM
4. Management Processor Memory
5. Management Processor EPROM
6. Pump Processor, 80C537
7. Management Processor, V25PLUS
8. ASIC
9. EPLD
10. 4.8 Volt NiCad Battery
11. 3.0 Volt Lithium Battery
12. Main Battery Charger
13. Touch Switch for manual turn off
14. Bezel/Door Connector
15. Motor Drivers
16. Backup Alarm
17. Main Battery Connector
18. Fuse 2, Main Battery Switching
19. Fan/Speaker Connector
20. Power Supply Connector

Note: It is good practice to treat all ICs as if they were Static Sensitive devices. It is recommended that a static discharge device and handling methods be employed when servicing this device.

Removal:

1. Remove the case top.
2. Attach a static discharge device such as a wrist band connected to ground as per the device manufacturer's instructions. When transporting or storing the EPROMs, static free packaging is recommended.

CAUTION: If you will be working on the main board with the EPROMs removed, it is strongly recommended not to power up the Main PCB. Otherwise, the ASIC can power up with one or more of the motor windings permanently enabled, and cause them to overheat.

3. Locate the two EPROMs in the middle portion of the Main PCB, Item 3 and 5 of Figure 7-4. Using a nonconductive material, pry the chip carrier tabs away from the Main PCB and remove.
4. If the plastic IC carrier is broken, obtain a replacement from the factory.
5. The EPROMs can only be inserted one way so long as the plastic chip carrier is intact. Refer to Figure 7-4 for the location on the Main PCB.

7.6.4 Main Board

Removal:

See Figure 7-4.

1. Remove the case top.
2. Disconnect the three connectors from the rear of the Main PCB. J2 is the 15 pin power supply connector, Item 20. J4 is the 4 pin fan and speaker connector, Item19. J3 is the 4 pin battery connector, Item17.
3. Grasp each side of the Main PCB and with a firm gentle rocking motion pull the Main PCB up.

Installation:

1. Place thumbs on either side of the Main PCB and press the Main PCB onto the 100 pin mechanism connector.
2. Place the connectors onto the Main PCB as follows:
   - •Main battery connector into J3.
   - •Fan/Speaker connector into J4.
   - •Power supply connector into J2.

7.6.5 Main Battery

Removal:

1. Remove the case top and Main PCB.
2. Unfasten the self locking nut with a 3/8" nut driver.
3. Remove the nut, retaining plate, and green door latch ground wire.
4. Lift and remove the bracket and battery.

Installation:

1. The power supply should be in place. Inspect the battery for any damage.
2. Place the battery wires against the surface of the battery.
3. Slide the battery bracket over the battery.
4. Hook the battery bracket's tabs onto the power supply mounts, and lower the battery and bracket into place.
5. Place the battery bracket mounting plate (rectangular metal washer) over the threaded bolt protruding up from the power supply through the battery case.
6. Place the green door latch ground wire followed by the nylon threaded nut onto the protruding power supply bolt and tighten until secure.

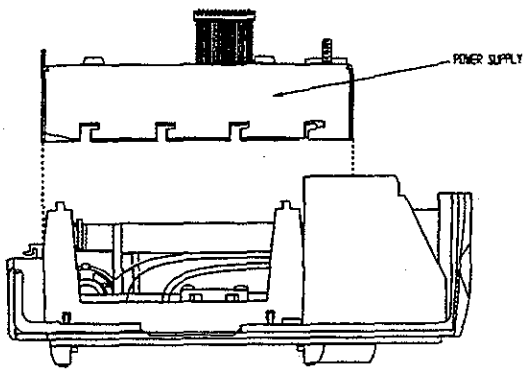
Note: It is recommended that new batteries must be charged for 24 hours prior to being used on patients for transport.

7.6.6 Power Supply

Removal:

1. Remove the case top, Main PCB, and battery.
2. Remove the AC electrical cord by pulling up on the three prong connector inside the case bottom.
3. Lift and remove the plastic Daisy Chain frame from the Daisy Chain outlet. Note its orientation.
4. Grasp the sides of the power supply and slide it sideways toward the Pole Clamp side of the instrument. This will detach it from the case bottom.
5. Lift and remove the power supply.

Figure 7-5: Power Supply Removal



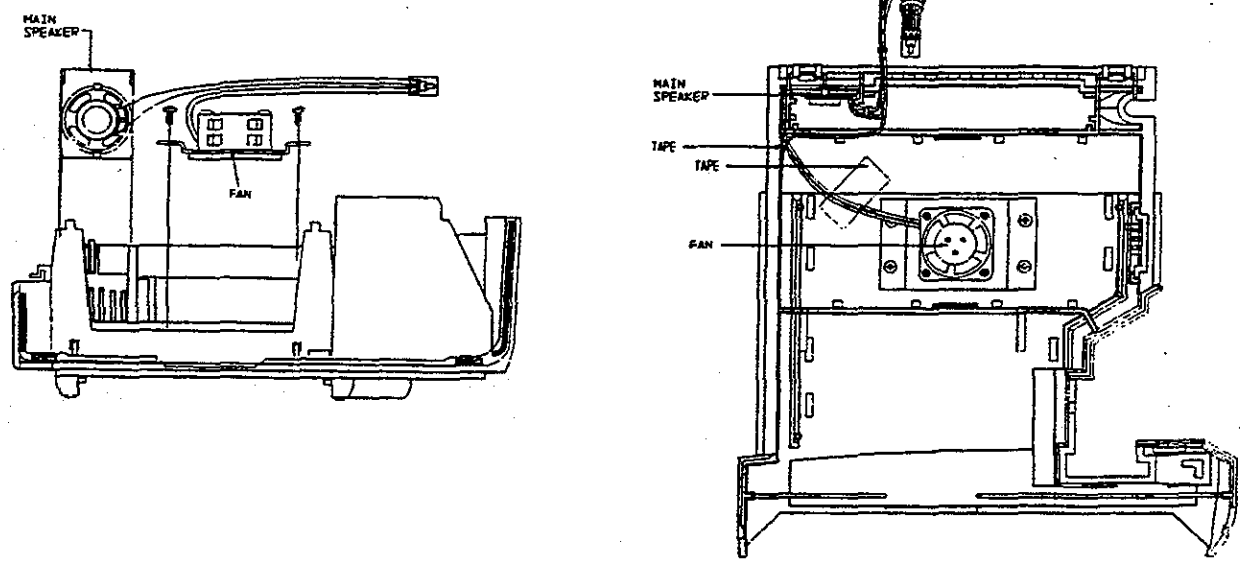
Installation:

See Figure 7-5.

1. Position the case bottom on your work surface such that the inside is visible.
2. Make sure the fan is properly positioned and secure to the case bottom.
3. Locate the eight hooks protruding from the inside of the case bottom, near the middle.
4. Locate the eight notches in the bottom of the power supply.
5. Position the power supply as in Figure 7-5 and lower it onto the hooks in the case bottom.
6. Secure the power supply by sliding it from right to left, as viewed from the front of the pump.
7. Verify the position by attempting to lift (by hand) the power supply out of the case bottom prior to disengaging it from the hooks. You should not be able to lift the power supply out by hand without first disengaging by sliding it from the left to the right.
8. If the power supply is not secure, remove and check for obstructions or broken components. Verify that the black and white wires connected to J1 inside the power supply housing are pressed against the power supply case. The open area in the middle of the board allows clearance space for the fan assembly.
9. Replace the Daisy Chain door frame clip. If the frame does not fit, engage the power supply more tightly onto the case bottom hooks by sliding it away from the Daisy Chain outlet. Do not force the frame into place.

7.6.7 Cooling Fan and Main Speaker

Figure 7-6: Fan and Speaker Placement



Removal:

1. Remove the case top, Main PCB, battery, and power supply.
2. Locate the fan in the middle of the case bottom and remove the four retaining screws that hold the fan in place.

Note: Note the location of the tape holding the fan wires in place. It is important to replace this tape and route the wires correctly to prevent the power supply case from damaging the wires.

3. Locate the Main Speaker in the rear most portion of the case bottom. Remove the plastic retainer bracket by using a small flat blade screwdriver to push up on the corner tabs.
4. Remove the fan and speaker assembly.

Installation:

See Figure 7-6.

1. Slide the speaker into the retaining bracket from the side.
2. Insert the retaining bracket into the left rear most corner of the case bottom. Make sure the right and left side tabs slide behind the case bottom ridges. Push the assembly down and check for movement of the speaker. If the speaker moves, adjust and push down the retaining clip.
3. Fasten the fan and gasket to the case bottom with four retaining screws.
4. Secure the fan wires to the case bottom with polyester tape.

7.6.8 Petal Cover

Removal:

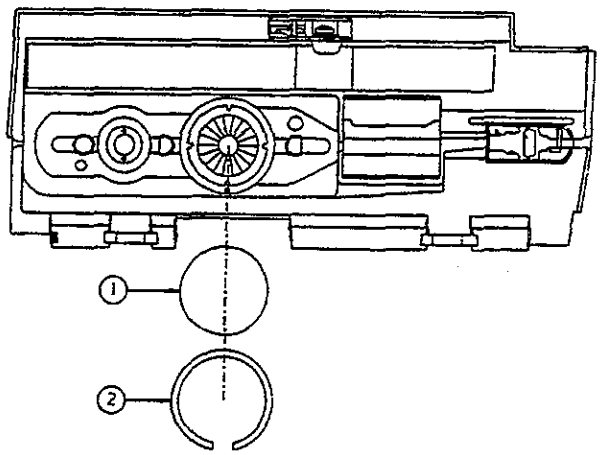
See Figure 7-7.

1. Position the pump with the door facing you. Open the door until the face is flat on the work surface.
2. Using the small flat blade screw driver, gently pry loose the black plastic snap ring (2) that holds the petal cover in position.
3. Remove the petal cover. (1)

Installation:

1. Attach the petal cover over the petal module as shown. The concave portion should be facing the petal module.
2. Snap the petal cover retaining ring in place.

Figure 7-7: Petal Cover



7.6.9 Half Door/Bezel Assembly

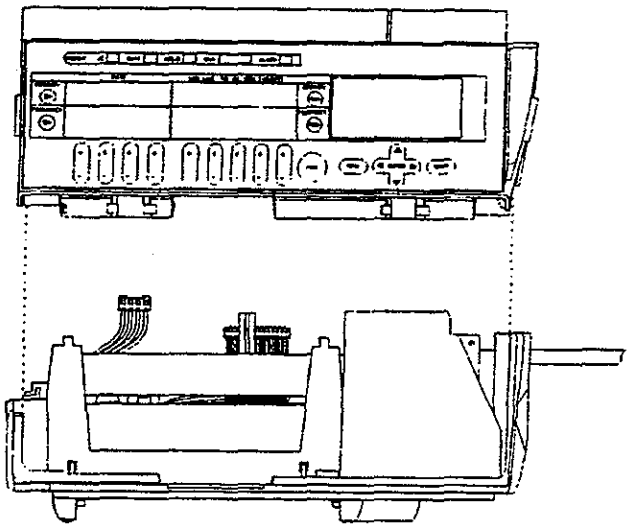
Removal:

1. Remove the case top and Main PCB.
2. Remove the green door latch grounding wire by removing the nylon threaded nut from the power supply bolt.
3. With the door closed, grasp the half door/bezel assembly near the center. Lift the half door/bezel up and out from the case bottom.

Installation:

1. Place the case bottom on your work surface such that the channel guides nearest the front of the case bottom are easily visible. Usually this is with the front facing yourself and the case feet touching the work surface.
2. Locate the grooves on each side of the half door/bezel assembly that run parallel to the face of the bezel.
3. Hold the half door/bezel assembly in both hands. Position the grooves in the half door/bezel assembly over the two channel guides in the case bottom. Allow the unit to slide down into the case bottom taking care NOT to force the fit. The fit should be snug with the top of the channel guides and flush with the top of the grooves.
4. View the assembled unit from the top making sure the half door/bezel assembly is not misaligned in the case bottom. The half door/bezel assembly grooves should fit squarely onto the channel guides. If not, remove and check for any obstruction, then reinstall.

Figure 7-8: Half Door/Bezel Assembly Removal



7.6.9.1 Air-In-Line Assy.

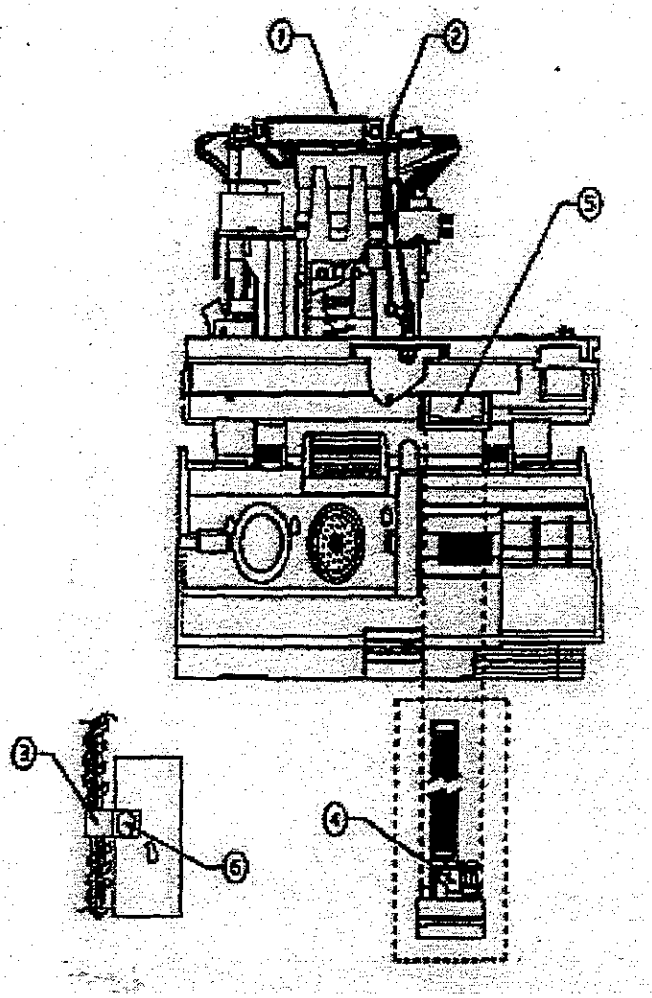
After replacing the air-in-line assembly, check out the assembly for proper operation. Refer to Section 3.6, Table 3-2, Steps 14-17.

Removal:

See Figure 7-9.

1. Disconnect J5 (Air-In-Line) 10-pin ribbon cable connector from header (1) on the Interface PCB (2).
2. Remove the cable clamp (3) from the Air-In-Line ribbon cable.
3. Open the door on the half door/bezel assembly.
4. Use a small flat head screwdriver to press on the two Air-In-Line retaining clamps (4) from the back of the bezel assembly and push the Air-In-Line assembly toward the door and remove the Air-In-Line assembly from the half door/bezel assembly.
5. Clean the RTV silicone rubber coating around the Air-In-Line area on the bezel assembly (5).

Figure 7-9: Air-In-Line



Installation:

See Figure 7-9.

1. Apply the new RTV silicone rubber coating, B. Braun P/N 145005 (Dow Corning 3140 RTV), around the opening in the bezel for the Air-In-Line assembly.
2. Install the Air-In-Line assembly into the bezel assembly. Use a small flat head screwdriver to snap the two Air-In-Line retaining clamps in place.

CAUTION: Air-in-Line retaining clamps can break with excessive force.

3. Clean excessive RTV silicone coating around the edge of the Air-In-Line area (5), if any.
4. Connect the Air-In-Line 10-pin ribbon cable connector to header J5 on the Interface PCB (1). Make

sure that pin 1 (indicated by an arrow head) on the 10-pin ribbon cable connector and pin 1 on header J5 on the Interface PCB are properly aligned.

5. Gather loose wires from the Air-In-Line assemblies and position in the cable clamp (6). Align the cable clamp with the hole in the restriction bracket and install the nylon snap rivet.

CAUTION: Take care not to allow RTV into the tubing channel of the Air-In-Line assembly.

7.6.10 Cosmetic Bezel

If you are going to simply be checking connections inside the door, or removing the cosmetic bezel or LED/LCD PCBs, do not remove the door at the hinges.

Removal:

1. With the door closed, position the pump flat on the work surface facing yourself. Rotate the pump upside down and remove the three Phillips head screws on the bottom of the door.
2. Remove the cosmetic bezel by prying the snaps along the top. Carefully disconnect the ribbon cables from the LED PCB.

Installation:

1. Connect the ribbon cable to the LED PCB.
2. Slide the cosmetic bezel over the door.
3. Install the three Phillips head screws into the bottom of the cosmetic bezel.
4. Snap the top of the cosmetic bezel into place.

7.6.11 LED Display/LCD Controller PCBs

Removal:

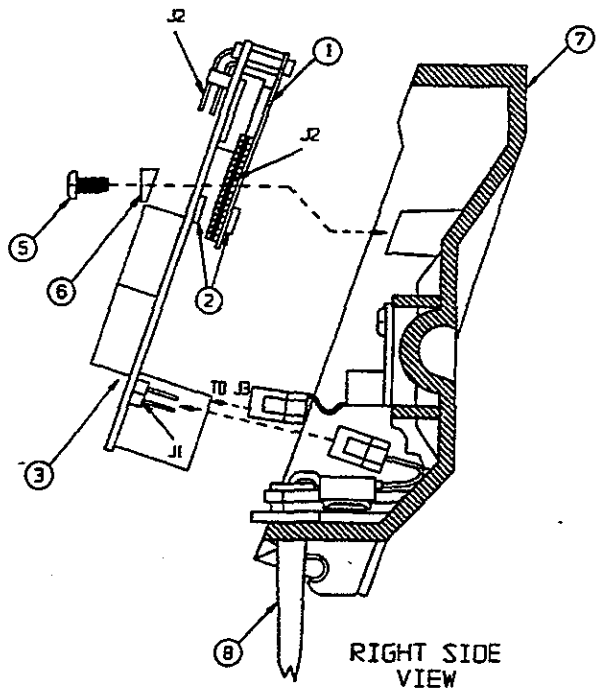
1. Remove the cosmetic bezel (see previous page).
2. Locate and remove the single Phillips screw in the center of the LED display PCB and note the orientation of the angled washer. Now pull the PCB forward.
3. Disconnect J2 (LCD) first then J3 (pressure transducer) and J1 (door cable).

Installation:

See Figure 7-13.

1. The LCD board, door cable, tube pusher, LCD controller board and pressure transducer board should already be installed.
2. Plug the cable from the LCD board into J2 of the LCD controller board (1). Visually check the top and bottom edges of the connection, making sure it is correctly attached.
3. Plug the door cable (8) into J1 on the LED display PCB.
4. Plug the pressure transducer cable onto J3 of the display board.
5. Verify that the LCD controller board (1) is firmly connected to the LED display board (3) by squeezing the two installation connections together one final time.
6. Prior to installing the mounting screw (5), align the PCB to the left, up against the two ribs inside the door. Look through the screw hole in the center of the board and verify that the board comes into firm contact with the screw mount when you press the board downward into place. If the board is not fitting into position, it is most likely caused by door cable or pressure transducer cable interference. Both of these cables need to be folded properly downwards into the door. The pressure transducer cable folds down beneath its board into the door cavity.
7. Now, while holding the LED Display board in position, snug the mounting screw tight onto its wedge washer (6).

Figure 7-13: LED Display Board



7.6.12 LCD PCB

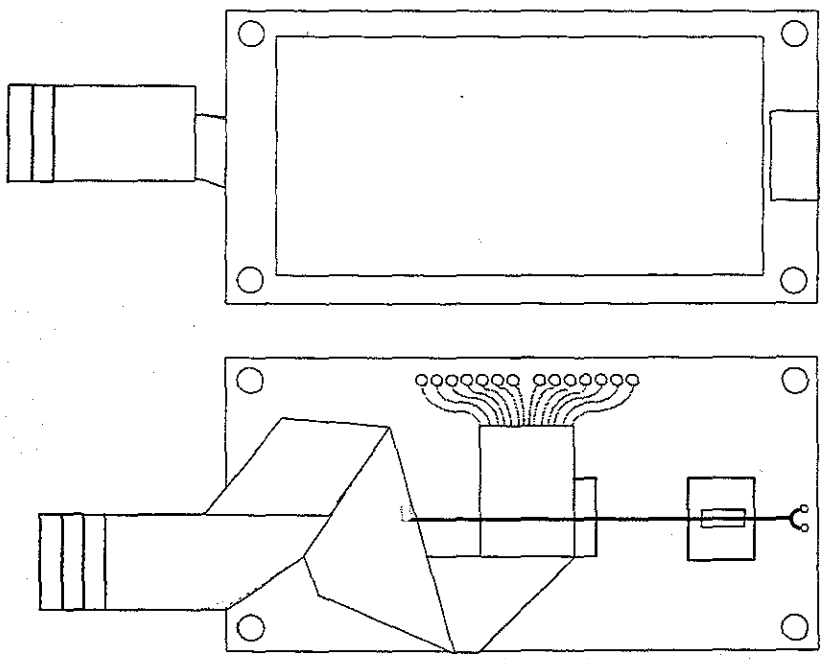
Removal:

1. Remove the cosmetic bezel.
2. Remove the LED PCB.
3. Remove the four Phillips screws located at each corner of the LCD PCB.
4. Disconnect the ribbon cable from the LCD controller PCB (J2) and remove the LCD.

Installation:

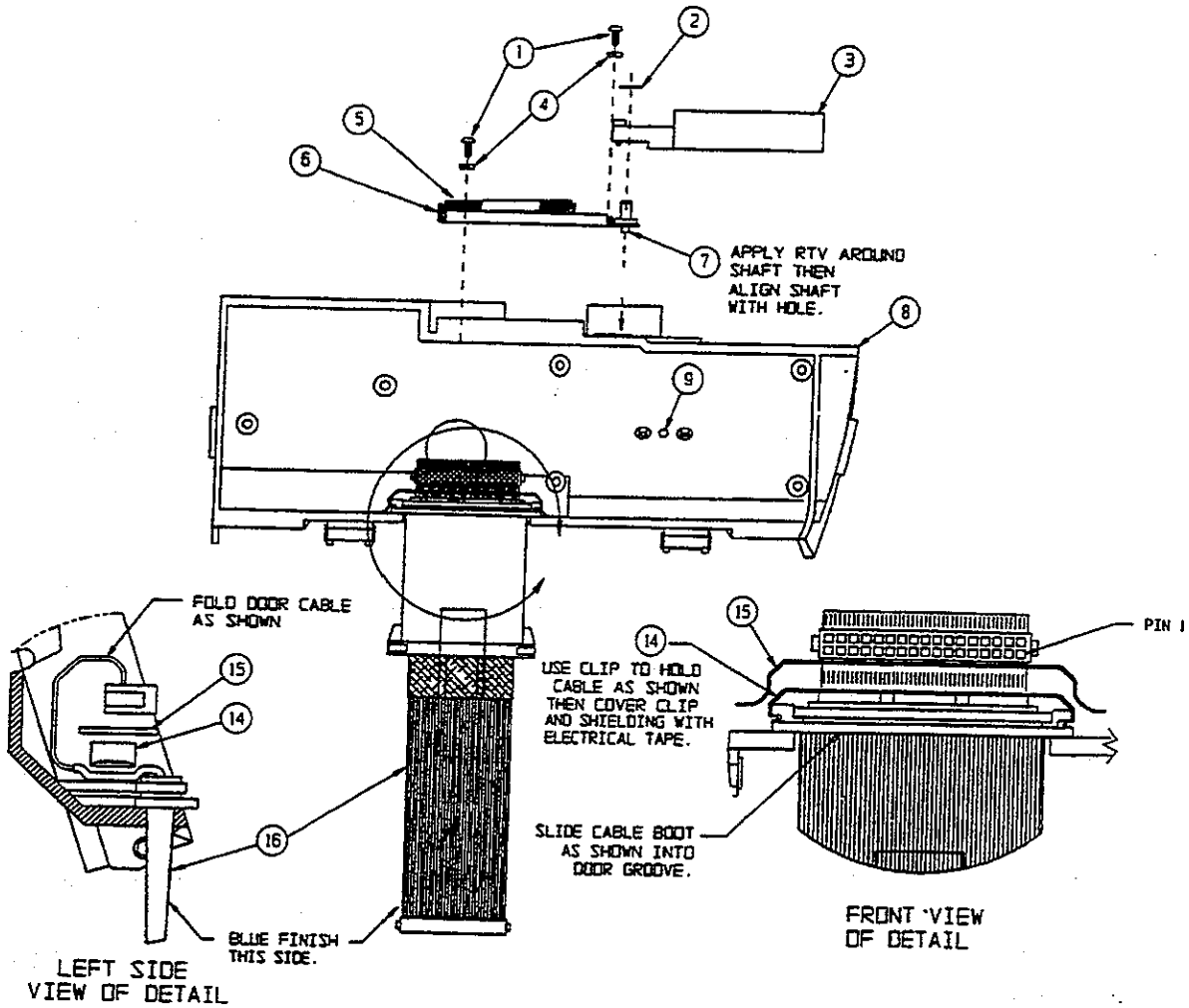
1. Be sure the tube pusher, Item 11 in Figure 2-5 is installed in the door and is functioning with a spring movement.
2. Be sure the door spring seal is properly in place.
3. Be sure the ribbon cable is not pinched between the mounting post and the PCB as the cable may short to chassis ground thus causing the LCD to function erratically.
4. Attach the LCD to the door with four screws (5) and angled washers (6) as shown. Snug the screws tight, if overtightened the PCB will crack near the screw hole.

Figure 7-14: LCD PCB, Front and Rear



7.6.13 Door Lever

Figure 7-15: Door Lever


APPLY RTV AROUND SHAFT THEN ALIGN SHAFT WITH HOLE.
FOLD DOOR CABLE AS SHOWN
USE CLIP TO HOLD CABLE AS SHOWN THEN COVER CLIP AND SHIELDING WITH ELECTRICAL TAPE.
PIN 1
SLIDE CABLE BOOT AS SHOWN INTO DOOR GROOVE.
BLUE FINISH THIS SIDE.
LEFT SIDE VIEW OF DETAIL
FRONT VIEW OF DETAIL

Removal:

See Figure 7-15.

1. Remove the cosmetic bezel.
2. Remove the E-ring from the door lever shaft and lift the lever off.

Installation:

1. Slide the door lever (3) onto the door lever shaft.
2. Attach the E-Ring clip (2) into the shaft groove.
3. Move door lever back and forth to assure ease of movement.

7.7 CALIBRATION, ADJUSTMENTS, AND SPECIFIC TESTS

The pump should be tested as defined in Section 7.4 "Procedures Requiring Case Disassembly (12 month)," following calibration or adjustment of any of the following items.

7.7.1 Electronic

The circuitry of the pump has been designed without adjustable components and thus it does not require calibration.

7.7.1.1 Testing the Pressure Transducer A/D Offset (Occlusion Verification)

To test the software A/D pressure transducer offset value, you will need to install a fully primed cassette in the pump and begin an infusion. Allow the pump to run one minute minimum into the KVO mode. Then place the pump on the Hold mode. In the Menu system, use the cursor to select "Biomed Options" and press the ENTER Key. Enter the BIOMED code and press the ENTER Key. Press the MENU Key, then cursor down to select "Check Configuration." Press the ENTER Key. With the software configuration information displayed, press the down arrow CURSOR Key.

The value displayed should be between 0 and 50 with a typical reading of 10-12. If the value is outside of these parameters, continue with additional testing.

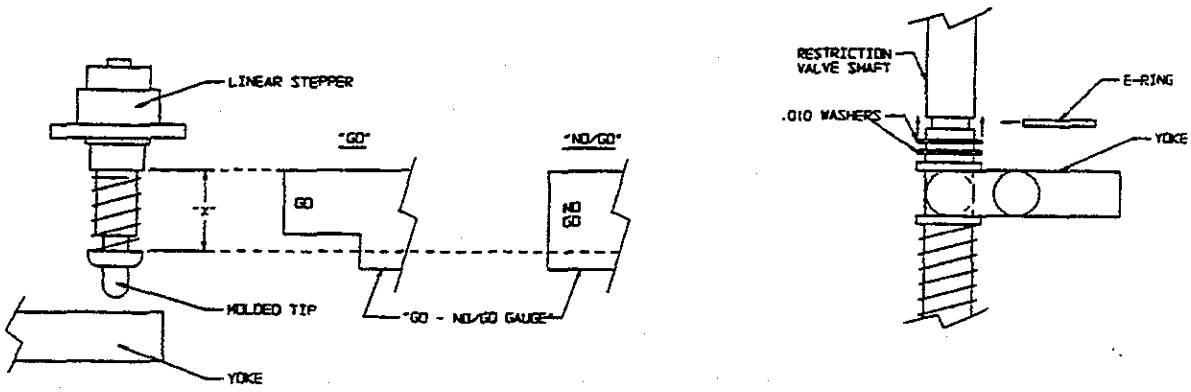
1. Disconnect from AC power and remove the case top.
2. Power the pump on.
3. Using a voltmeter, test pin 64 of J1 (mechanical interface connector) on the main PCB. With no pressure other than ambient pressure, the value should read between 50 and 600 mV. With a typical value in the 500 mV range. At higher elevations, the typical value will be less.
4. Brush your finger over the pressure transducer in the door to verify that the voltage increases as pressure is applied and returns to the previous no applied pressure value.
5. Replace the half door/bezel assembly if the voltage values or response are different from that described.

7.7.2 Mechanical

7.7.2.1 Restriction/Outlet Valve Yoke Adjustment

Perform whenever the restriction motor is exchanged. Also needed for false downstream occlusion alarms, as well as alarm codes #7 and #137.

Figure 7-16: Restriction/Outlet Valve Adjustment



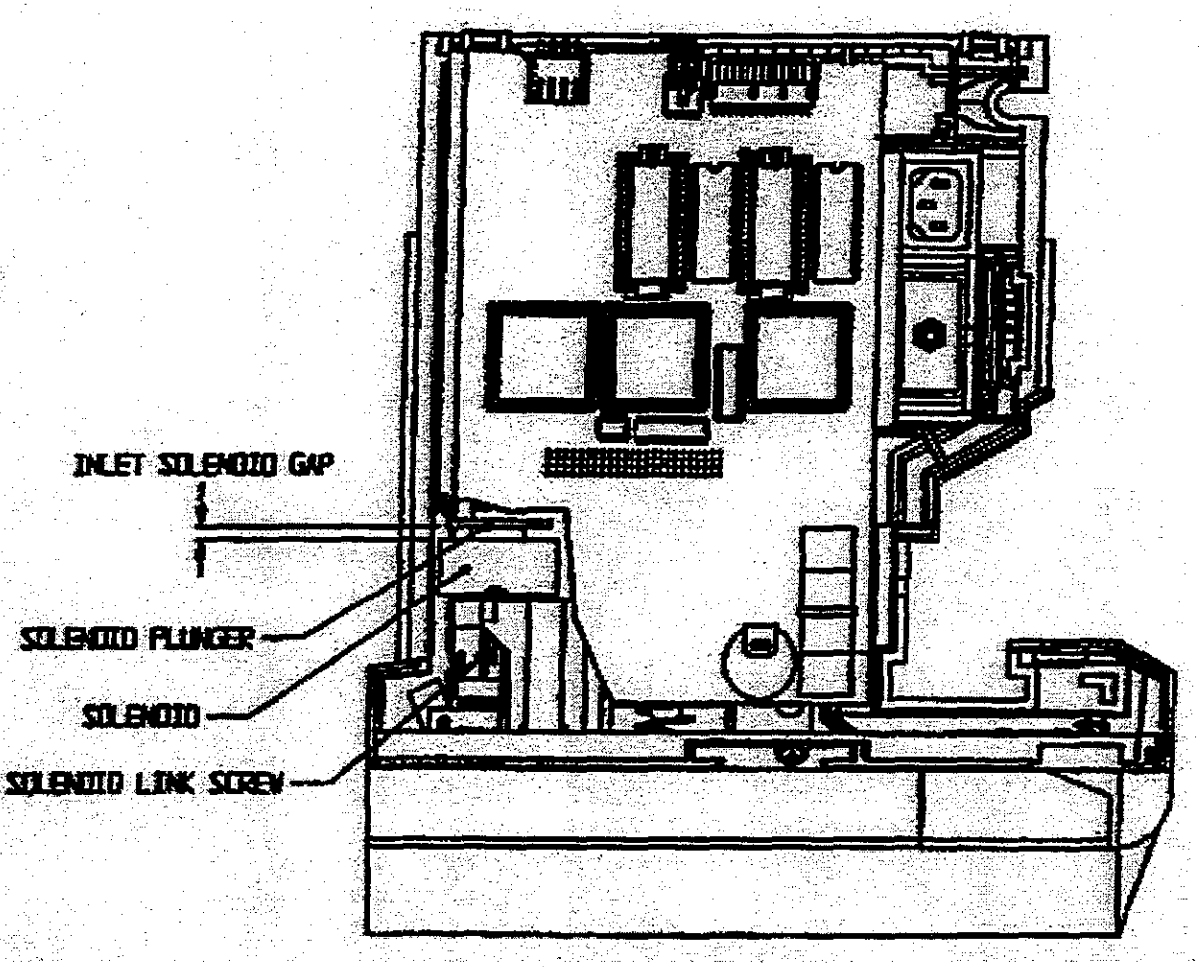
1. Remove the case top.
2. Install a fully primed new (less than 72 hours old) cassette into the pump.
3. Power on and run the pump for two cycles at a rate greater than 500 ml/hr.
4. Press the HOLD Key.
5. Do NOT open the door.
6. Power the pump off.
7. With a firm gentle rocking motion, disconnect the Main PCB from the Main PC connector. Flip it backwards out of the way.
8. Check the adjustment using tool #402069. The GO side of the gauge should fit between the shoulder on the linear motor and molded tip, marked "X" on Figure 7-16. The NO/GO side should not fit. If this is true, then no adjustment is needed. But, if the GO side does not fit, go to step 9. If the NO/GO side does fit, then adjustment is necessary; go to step 10.
9. If the GO side of the gauge will not fit then move one 0.005" nylon washer to the other side of the E-ring. This is done by removing the E-ring and moving one of the 0.005" washers above E-ring groove. Then reinstall E-ring and repeat steps 1-8.
10. If the NO/GO side of the gauge fits between the Linear/Restriction motor shoulder and molded tip, then a 0.005" washer should be moved to the other side of the E-ring. This is done by removing the E-ring and moving one of the 0.005" washers that are above the E-ring groove to below groove. Reinstall the E-ring. Then repeat steps 1-8.

Note: To relieve the spring force on the E-ring, open the door and press on the outlet valve tip.

7.7.2.2 Inlet Solenoid Adjustment

Perform whenever a half door/bezel assembly is exchanged or repaired. Also needed for false or lack of downstream occlusion (OCCL) alarms and false or lack of empty container (SOLU) alarms.

Figure 7-17: Inlet Solenoid Adjustment



1. Loosen the screw which tightens the molded solenoid link to the solenoid plunger thread, just enough so that the solenoid plunger, the circular disk on rear of solenoid, is free to turn.
2. With a primed set in place, power on the pump and begin an infusion at some rate greater than 500 ml/hr.
3. Use the inlet solenoid gap (feeler) gauge (P/N 398268 or equivalent) to verify the minimum gap between the solenoid and plunger is 0.011-0.014 inches. Measure when the plunger engages. If required, press the HOLD Key then rotate the plunger in small increments and restart the infusion. Then recheck the gap. Repeat this until the gap requirement is met.
4. Tighten the screw on the solenoid link to lock the plunger into position.

CAUTION: Overtightening the solenoid link screw can break the solenoid link. Tighten only enough to prevent the solenoid plunger from rotating.

5. The pump must now be completely tested (see Sections 3.6, 7.3.4, and 7.3.5).

8.0 PARTS LISTS, SCHEMATICS AND DRAWINGS

8.1 PARTS LIST

It is the intent of B. Braun to allow the Biomedical Service Professional to repair and/or replace to the PCB and component level. If you wish to repair the device yourself and have any questions, please contact Technical Support at B. Braun (see Chapter 9). The present list of replaceable subassemblies and parts will be made available to you upon request.

8.2 ELECTRICAL COMPONENTS AND SCHEMATICS

Selected engineering schematics include:

Power Supply Assy. 256009
Mechanism Interface Board Assy. 256008
NXT Main Board Assy. 256035
NXTP Main Board Assy 256038